The outer limit of the tornado's path was sharply defined. A typical example was found in the instance of a house which we own, the corner of which was located 18 feet from the corner of a similarly constructed adjoining house. Our house was completely undamaged, while the adjacent house was completely destroyed.

Another example was found in the instance of a lightly built cottage with a slightly supported open porch, located immediately across the street from the lumber yard and mill-working establishment referred to above. While the latter was very badly damaged, the flimsy cottage across the street was not harmed in any way.

The captain of a large dredge anchored at Port Everglades, a few miles southeast of Fort Lauderdale, advised me that the tornado in coming in from the ocean passed between his dredge and a large barge anchored some 400 feet to the north without striking either. He advised me that he saw no evidence of a waterspout in connection with the tornado.

Mr. E. A. Pynchon, a civil engineer and shipyard owner of Fort Lauderdale, was watching a recording barometer in Flippen's hardware store when the storm center passed within some 300 or 400 feet of that building. He states that the needle dropped abruptly nine points, quivered at the low point for a few moments, and then rose abruptly to the original reading. The graph record indicated a vertical line drop and rise of five points.

The passing of the tornado apparently marked the peak and end of the hurricane disturbance at Fort Lauderdale. Within 30 minutes after its passing a decrease in the intensity of the hurricane winds was definitely noticeable, and within two hours the wind velocity was probably down to 30 miles an hour or less. Thunder and lightning had developed in the east by that time, and the storm decreased continuously thereafter. The recording barometer indicated a steadily increasing pressure after the passage of the tornado.

ADDITIONAL EVIDENCE

Following is an excerpt from the report of the cooperative observer at Fort Lauderdale:

> I did not see the tornado, but heard the noise, but as the hurricane was causing so much noise did not notice that of the tornado. My daughters were sitting in the bedroom on northeast side of the house, and came running to the porch and wanted to known what the air was filled with that was going past on the north side of my house. Some who saw the tornado speak of it as a "ball of fire." The tornado went through the city bouncing like a ball; places in its path would not be touched, then it would strike some building and tear it into pieces.

THE STATUS OF CLIMATOLOGY OF THE AGES

551.583

By MARSDEN MANSON

Physical facts are the language of Nature and every expression uttered by her is worthy of our most attentive consideration—MAURY.

When the climatologist turns from his volumes of observed data to the climatic records made by natural processes he enters one of the most interesting and important fields of his science.

He can not climb a mountain in any latitude to an altitude at which glaciers yet rest without finding evidences of their retreat and of the corresponding advance of forest growth. It makes no difference where these observations be made, whether in reaching the feeble remnants of glaciers in the Sierra Nevadas, the Alps, the Himalayas, or upon Ruenzori, Chimborazo, the greater glaciers of Alaska or Patagonia, or the vast ice sheets in polar latitudes, the records are the same—*continuous retreat*. Possibly fluctuating slightly, but everywhere the integrals of successive retreats are far greater than those of advances.

Retracing his steps he can observe what may have escaped his notice at first, that the glaciers once extended to lower and lower slopes, until, in temperate latitudes. they reached the bases of the mountains and left morainic soils on which grapes, olives, and oranges now flourish, or in tropical and equatorial latitudes the evidence of glaciation are buried in dense forests only a few thousand feet above sea level.

Should his studies be broadly conducted he can trace these evidences of deglaciation across a continent and to the north of these limits vast glacial lake beds now producing abundant crops of wheat and oats.

In this he enters the enticing fields of paleo-climatology. In these he is called upon by the geologist to explain the evidences of a series of alternations between severe and destructive glaciation and the geniality of the insolation in latitude, or the warm and cold interglacial epochs of Pleistocene glaciation; and the transition of the last of these warm epochs into existing conditions and the principles of physics involved in this transition.

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All of his observations establish a distribution of temperatures entirely different from those of to-day, and contradicting every principle of modern climatology. He will be forced to the conclusion that the retreat he has so clearly traced, and observed as yet in progress, reveals the closing chapters of a distinct transition from the conditions and control of paleo-climates into those of modern climates.

Neither branch of his science, as at present taught, gives in any particular the reasons for this change or transition between the two distinctly different and contradictory climatic records, nor why, when, where, and how modern climates began and paleo-climates ended, or of the causes of the stages in this transition. Nor again to the naturally suggested question, to what conditions do the progress and control, evidently inaugurated at some indefinable period and in some undetermined regions, now lead? He is irresistably led into the interpretation of these enticing and unmistakable records which are contrary to the distributions of modern climates, contradict them by glaciations in all latitudes which could not occur under the accepted constancy of direct solar radiation, nor do they yield to any assumption of variation in solar radiation, for they are utterly incongruous to such direct control as solar energy can impose on a planetary surface inclosed in air and having water within its control; contradicts them by the glaciations of temperate latitudes extending into polar latitudes, while tropical latitudes at or near sea level continued to enjoy the geniality of their insolation; contradicts them by the most severe and destructive glaciation recorded at sea level in tropical latitudes during Permo-Carboniferous time, coincident with subpolar and polar geniality with no sign of glaciation. These considerations lead us into paleo-climatology and into the period or periods and the latitude or latitudes in which the

transitions between the two great divisions, modern and paleo-climatology, occurred and into the tendency of climatic advances of the present era.

Returning to our climatologist's observations on his ascent from lower levels in middle or in tropical latitudes, on either his ascent to or descent from the yet existing glacier levels, he will note that the various species of trees are ranged between definable limits, whether coniferous or deciduous they have definite limits which are slightly higher on south exposures. Each species has its limits, but each is pushing its upper limits into the lower limits of the next species above, until, as he reaches the timber line the hardiest conifers, aspens, and willows are pushing their dwarfed and struggling forerunners toward the retreating glacier level. These records are the same in whatever latitude the glacier limits are approached.

These plainly legible records establish the fact that one of the most characteristic and distinguishing features of present climatic distribution and control compared with geological climates is deglaciation, that whatever may have been the conditions and control which permitted the last, or Pleistocene glaciations, to be laid down, these conditions and control no longer prevail in any latitude, and have been completely reversed, so as to cause progressive deglaciation and amelioration in proportion to insolation in latitude and altitude to alternately and then permanently take the place of refrigerations and glaciations.

In other words, the cumulative effects of insolation under present climatic conditions are still removing refrigeration and glaciation and extending in their stead more genial conditions.

The present retreat of glaciation and the advance of vegetation over the deglaciated areas establish the actual progressiveness of geniality over the entire globe. This advance is not in harmony with the conclusion of Abbe:

> It is evident that our planet, considered as a whole and on the average of many years, loses all the heat which it receives from the sun, but all the details of this process have not been worked out.[1]

This conclusion, however, held and supported by the interpretations of meteorological observations, can not stand in the face of the direct evidence naturally recorded throughout the world and just reviewed. It must, therefore, be abandoned and replaced by the conclusion that present climatic conditions are not static nor in equilibrium but are advancing toward a condition advantageous to human life, and that the climatologist must consider his science as dealing with progressive conditions.

In the practical work of the meteorologist, or the forecasting of local weather changes, the gradual advances herein pointed out are of no use. But it must be realized that the present climates are the results of agencies yet progressing in their results, and are essential to a clear understanding of the facts and the basic principles of physics involved in the genesis and advance of the climates with which he has to deal.

It is well known through the researches of many investigators that, in general, water vapor is transparent to incoming short-wave radiation but opaque to outgoing long-wave radiation.

Recent investigations by Simpson and others seem to prove that the absorption of solar heat just balances terrestrial radiation of heat. In all of these investigations, however, instrumental measures and the deductions therefrom are not of so refined a character as to close the door to the possibility which may be a certainty, that there is a small residual of incoming in excess of outgoing radiation.

This process was manifestly established as Pleistocene glaciation began its final retreat, and within certain reasonable limits is cumulative; it is yet active; this activity is being recorded by retreating glaciation and advancing geniality, as above pointed out.

This advance in certain local and minor instances may have been fluctuating, but the major facts are indisputable and convincing.

We must therefore adjust or modify the principles of climatology to meet the requirements which the naturally recorded phenomena plainly establish and known principles of physics account for.

The phenomena with which climatology has to deal are therefore not static nor in equilibrium, but are advancing toward a condition in which the moss of the tundra will give way to rye and wheat and "ice covered polar wastes will be useful to the human race."

There are therefore two vital and important inquiries of great import in the status of climatology.

(1) From what conditions and control did the changes from geologic climates come?

(2) To what condition do the changes but recently inaugurated tend?

Until climatologists are able to grasp the meaning of the actual records confronting them they have a limited conception of the scope of their science and of its importance to the ultimate future of the human race.

There are two manifest fallacies which must be discarded before climatology can rest upon an assured basis, particularly in the division of paleo-climatology.

Intensive research by geologists into the climates of the past has revealed the fact that the present distribution and control of climates are distinctly different from those of the past.

These great differences have necessitated the division of climatology into modern and paleo-climatology. This distinction sets apart the climates of to-day from those of the past ages only by scientific nomenclature, for when it is asked how, when, where, and why did the changes or transitions from one to the other take place, neither branch of the science gives any definite answer to questions which any high-school student might be expected to ask.

Again, since curiosity is the mother of research, he might be tempted to ask, Where do the conditions which this transition inaugurated lead?

The writer can not find in any text or manual on climatology satisfactory answers to these questions.

The status of climatology as a science is therefore indefinite and unsatisfactory as to how the genesis of present climates was brought about and as to what conditions they tend.

One of the most direct references to this transition is found in Geikie's Text Book of Geology where, after reviewing the great fluctuation of climates in the Pleistocene ice age, he says:

> The long succession of Pleistocene ages shaded without abrupt changes of any kind into what is termed "The human or present period."[2]

However lacking in abruptness this shading or transition may have been, it is not lacking in its reality and in the significance of its results, as completing the most momentous transitions of climatic, geologic, and biologic history, accomplished through a succession of interrupted transitions or interglacial warm and cold epochs, and culminating in a final transition in each of the great zonal glaciations. These transitions were inaugurated "in the

[1] Am. Journal of Science, Vol. XLIII, p. 364.

[2] Vol. II, p. 1347.

midst" of climatic, geologic, and biologic history by a glaciation more severe and more incongruous than any recorded in the crust of the earth, for in Permo Carboniferous glaciation tropical latitudes were severely and destructively glaciated down to sea level, and subpolar and polar latitudes remained genial, thus reversing every principle of solar climatic distribution and control and offering "a plexus of problems of unparalleled difficulty."[3] The final transition was accomplished as Pleistocene glaciation merged in temperate and polar latitudes into existing climatic distributions.

Wide range has been given to the scientific imagination to develop solutions based upon hypotheses, assumptions and calculations resting upon assumed data, all resulting in unsatisfactory solutions of the climatic problems presented by the researches of geologists.

The last of these is Wegener's theory of floating continents. This is referred to by Dr. G. C. Simpson as follows:[4]

> There has recently been a considerable interest taken in problems connected with past climates. Wegener's revolutionary theory of the movements of the continents, associated with wanderings of the polar axis, has met with serious and strenuous opposition. One of the most important of the appeals of Wegener's theory is that it gives an explanation of the great changes of climate which geological evidence indicates to have taken place in many parts of the world.[5]
>
> This has been a direct challenge to opponents of the theory to produce explanations of these climatic changes on more conservative lines. Variations of solar radiation is the most obvious solution, but there are many patent objections to such an explanation and there seems a reluctance to postulate any but small changes in solar radiation. At any rate this is not a popular solution.
>
> Geologists look with much more favor on theories which depend only on changes in the physical status of the earth's surface; changes in the relative extent of sea and land, changes in ocean currents and changes in elevation, although the latter can only work in the direction of reducing surface temperatures.
>
> It seems to me to be the opinion of many geologists and not a few meteorologists that there is unlimited scope for the control of climate in the readjustment of land masses and the introduction of new ocean currents similar to the Gulf Stream.[6]

The "revolutionary" theory of Wegener does not appear to meet any of the rigid requirements of geologic climates as established by geologists; the crucial objections are:

(1) The floating of the continents upon a slip joint or surface discretely postulated beyond possible examination.

(2) The repeated alternation in climates during Pleistocene glaciation from severe and destructive glaciation to the geniality due the insolation in latitude calls for the floating of continental areas in both hemispheres from polar latitudes into temperate latitudes to be deglaciated and back again to polar latitudes to be reglaciated.

The same back-and-forth floatation between tropical and polar latitudes would be necessary to account for corresponding alternations in climate during Permo-Carboniferous glaciation and the floating would have to be far greater in latitude.

Moreover, the whole change is based on the unproved assumption of solar control of geologic climates, which assumption has proved unsatisfactory in all cases.

The hypothesis can not be allowed to stand as even one of the possible causes of climatic change.

[3] Chamberlin and Salisbury Geology, Vol. II, p. 655.
[4] In Past Climates, Quart. Journal Royal Mt. Soc. July 1927, pp. 213–230.
[5] W. Köppen and A. Wegener, der Klimate der Geologishen Vorzeit, Berlin, 1924.
[6] Seward Phil. Transactions B 215, 1926, p. 161, Brooks Climates through the Ages. London, 1926.

551.571

PSYCHROMETRIC OBSERVATIONS

By Capt. M. COYECQUE, Master Steamship *Basse Terre*

Psychrometric observations have been made during the voyage from Bordeaux, France, to Pointe-á-Pitre, Guadaloupe (September 11–26, 1929), with the object of realizing when there was any opportunity and advantage to open the hatchways for ventilating the cargo outside of the regular air current obtained by the ship's ventilators. The apparatus used was the regular Richard psychrometer, placed in a sheltered position, exposed to the wind and moved according to the sun's movement and the ship's course.

The absolute humidity in grams per cubic meter has been figured from the Smithsonian tables and the specific humidity in grams per kilogram calculated by the formula

$$H_s \frac{623f}{\text{p.} - 0.377f}$$

f being the absolute humidity or vapor tension in mm. and p. the pressure in millimeters. The observations have shown along the course indicated by ship's position the following results:

In the Gulf of Biscaye with fair weather, H_s was only 12.3 grams with a temperature of 20°.5 C. It decreased continuously between Spanish coast and Azores, showing a minimum of 11.3 grams in latitude 37 and longitude 31—in the southeast sector of a high-pressure zone slowly moving east-southeastward (wind NE. 3). After that day H_s increased slowly until latitude 31 was reached. The ship then passed into tropical air from southeast, after a heavy thunderstorm moving northwestward. The specific humidity, which had increased 3 grams in three days, made a jump of 3 grams in a few hours and maintained its degree afterwards.

From 17 grams it slowly reached 21 grams on the 24th in latitude 21 with appearance of cyclonic conditions in the region. As the weather conditions improved and showed less turbulency, H_s fell down to 19 grams, and increased again to 21.9 grams close to the Guadaloupe coast, with squally weather and temperature 27°.5 C. As a rule, morning observations made about 8 a. m., local time, showed higher specific humidity than p. m. observations. Evening observations were generally intermediate and close to p. m. data.

As a conclusion, the driest part of the voyage was the period southwestward of the Azores in the polar air of the moving HIGH. All the way farther south the air was richer in moisture than the air from Bordeaux, where cargo had been loaded.